HIGH POWER SIGNAL GENERATOR

MODEL 470A-500

MODEL 470A-1000

Stock No. A02547010B PRICE $5.00

FEBRUARY 1967

MP MASTER

MA31563

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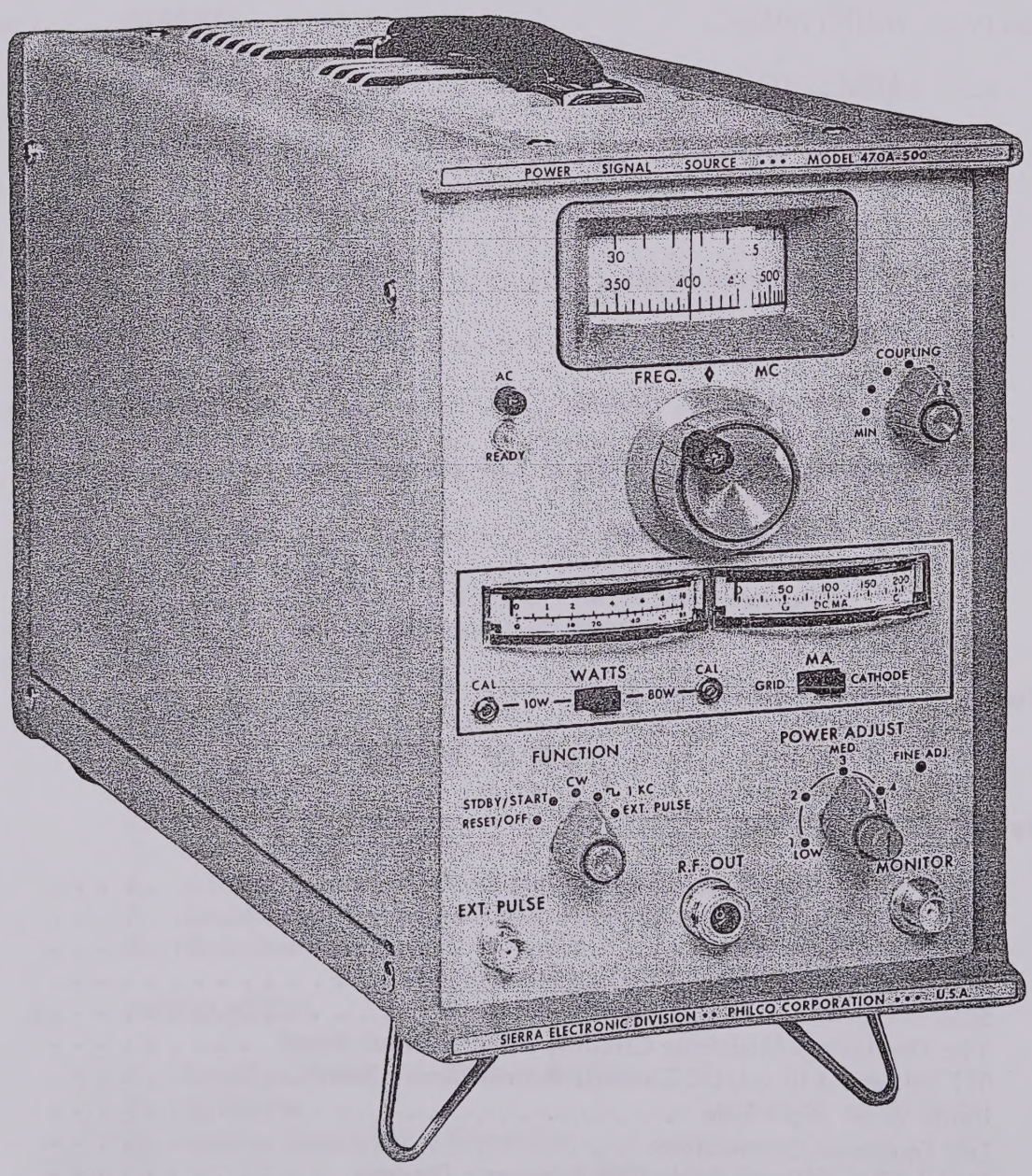


Figure 1-1. Model 470A-500 High Power Signal Generator

SECTION I
GENERAL

A. PURPOSE

The Sierra Models 470A-500 and 470A-1000 are High Power Signal Generators for use in the VHF-UHF region of the frequency spectrum. The output signal is of sufficient stability and power to be used in the testing and calibration of VHF-UHF power measuring equipment. The instruments may be used to test and calibrate RF Filters, RF Detectors, Receivers, Antennas and other VHF-UHF equipment. They are useful as the signal source in RFI testing applications.

B. DESCRIPTION

The 470A-500 and the 470A-1000 Signal Generators are the same in external appearance and in electronic circuitry. The difference is in the frequency ranges covered. See Specifications, paragraph C, for details.

The circuit arrangement of the instruments is shown in the block diagram, Figure 1-2. The power source is a resonant cavity tuned oscillator. Cavity tuning is by means of concentrically mounted pistons adjusted by a zero-backlash front panel control. Frequency is read directly on a long drum scale. A logging scale on the dial drum and a skirted tuning knob with numbered divisions on its circumference provides accurate resetability.

The output is either CW, square wave, or pulse modulated. Modulation is 100% and may be from an internal 1 kc square wave generator or from an external source.

Coarse and Fine controls provide continuous adjustment of power level over the full range of the instrument. Power supplies are all solid-state. The high voltage supply output is regulated for slow line voltage variations. Output Power and Grid-Cathode current are read on two front panel horizontal scale meters. The instrument is provided with protection against a no-load or under-load condition by an over-current relay in the grid circuit.

The side panels are held in place by quarter-turn, quick-release nylon fasteners. The circuit boards containing the electrical components are exposed when the side panels are removed. The oscillator tube is accessible through a snap-in hole plug in the rear of the cabinet.

WARNING

High (lethal) voltage is present on the end of the oscillator tube exposed when the hole plug is removed. Be sure instrument is unplugged from AC supply before attempting to change tubes or remove side covers.

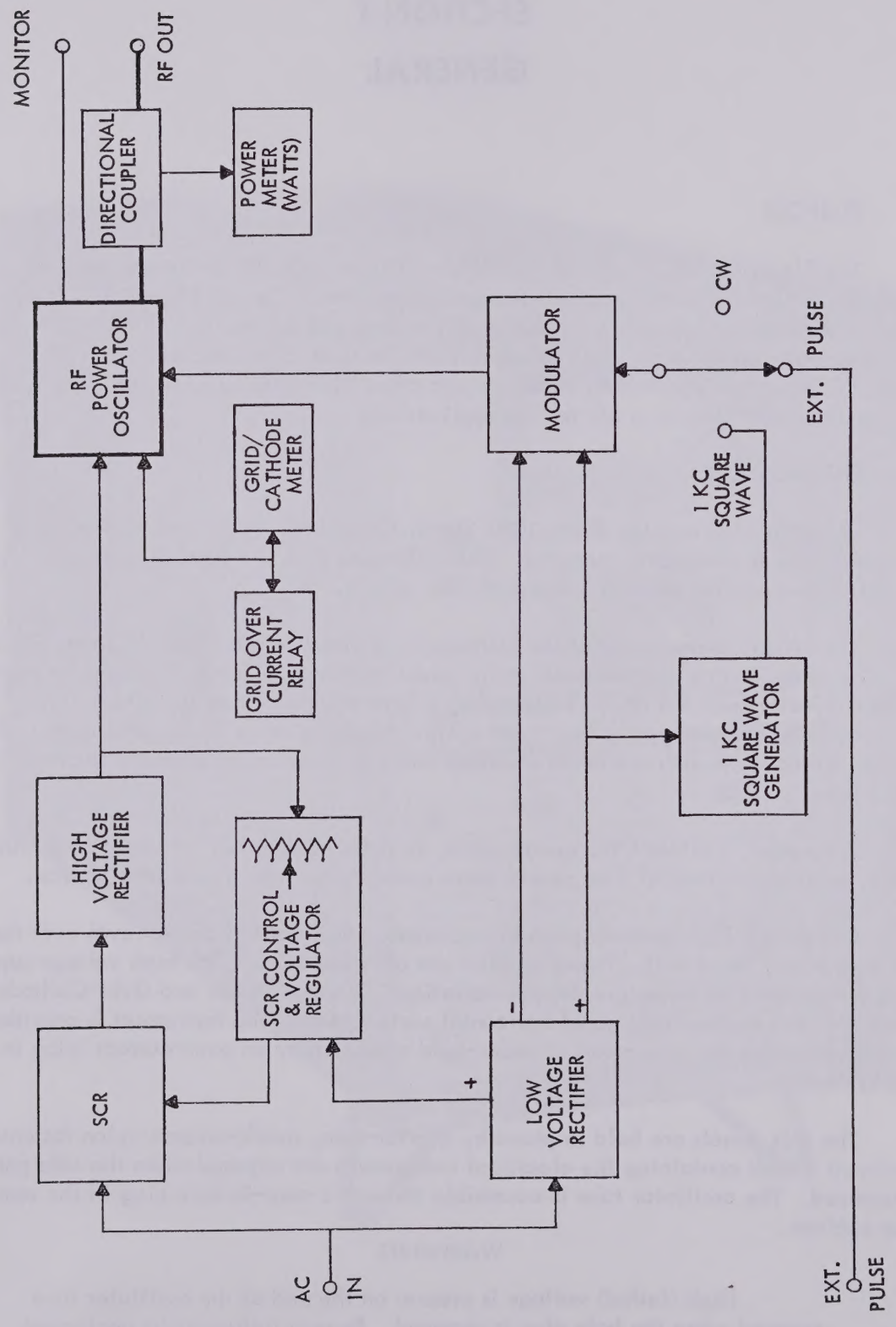


Figure 1-2. High Power Signal Generator Block Diagram

C. SPECIFICATIONS

MODEL 470A-500

FREQUENCY	
Range	200 mc to 500 mc Useable 190-600 mc
Stability	
Long term	0.02% per hour average after two hours warmup with constant load, ambient temperature, power output and line voltage, 200 to 500 mc
Short term	0.005% per 10 minutes average (Same conditions as above)
Resetability	0.01% average
Calibration, Direct Reading	±1%, 200 mc to 500 mc
Tuning	Single knob
POWER OUTPUT	
Range	50 milliwatts to not less than 55 watts at 190 mc 60 watts at 200 mc 70 watts at 300 mc 70 watts at 400 mc 60 watts at 500 mc 30 watts at 600 mc
Stability	±0.2 db per hour after 1/2 hour warm-up with constant load and line voltage, 200 mc to 500 mc ±0.2 db for 105-125 volts AC line voltage variation
Monitor Output	35 db below main output, approximately
POWER METER (Direct Reading)	
Ranges	0-10 watts 0-80 watts
Accuracy	±0.5 db, 200 mc to 500 mc

MODULATION	
Internal Square Wave	100%, 1000 ±10 cps
Rise and Fall Time	Less than 1.0 microsecond
External Square Wave	100%, 60 cps to 100,000 cps
Rise and Fall Time	Less than 1.0 microsecond
Input Level	Less than 10 volts p-p at 1000 cps Less than 30 volts p-p at 60 cps and 100,000 cps
Droop	10% at 60 cps
External Pulse	100%, up to 50% duty cycle at full rated power output
Rise and Fall Time	Less than 1.0 microsecond
Input Level	Less than +5 volts peak
Input Impedance	5000 ohms nominal
Residual FM	Less than 0.001% deviation above 1 watt Less than 0.01% deviation at 50 mw
Residual AM	Less than 1% above 1 watt Less than 5% at 50 mw
INPUT POWER	105-125 volts AC, 60 cycles, 5 amperes maximum
AMBIENT TEMPERATURE	
Operating	-10 to +120° F
Storage	-30 to +150° F
DIMENSIONS	
Height	10 inches
Width	6-3/4 inches
Length	18-1/2 inches
WEIGHT	37 pounds

MODEL 470A-1000

FREQUENCY

Range	470 mc to 1000 mc Useable 460-1010 mc
Stability	
Long term	0.01% per hour average after two hours warmup with constant load, ambient temperature, power output and line voltage, 470 to 1000 mc
Short term	0.003% per 10 minutes average (Same conditions as above)
Resetability	0.01% average
Calibration, Direct Reading	±1%, 470 mc to 1000 mc
Tuning	Single knob

POWER OUTPUT

Range	50 milliwatts to not less than 55 watts at 470 mc 60 watts at 600 mc 65 watts at 700 mc 65 watts at 800 mc 60 watts at 900 mc 55 watts at 1000 mc
Stability	±0.2 db per hour, after 1/2 hour warm-up with constant load and line voltage, 470 mc to 1000 mc ±0.2 db for 105-125 volts AC line voltage variation
Monitor Output	35 db below main output, approximately

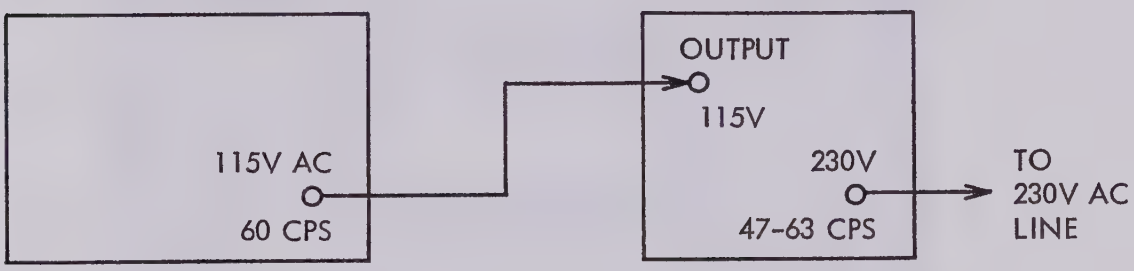
POWER METER (Direct Reading)

Ranges	0-10 watts 0-80 watts
Accuracy	±1 db, 470 mc to 1000 mc

MODULATION	
Internal Square Wave	100%, 1000 ±10 cps
Rise and Fall Time	Less than 0.5 microsecond
External Square Wave	100%, 60 cps to 100,000 cps
Rise and Fall Time	Less than 0.5 microsecond
Input Level	Less than 10 volts p-p at 1000 cps Less than 30 volts p-p at 60 cps and 100,000 cps
Droop	10% at 60 cps
External Pulse	100%, up to 50% duty cycle at full rated power output
Rise and Fall Time	Less than 0.5 microsecond
Input Level	Less than +5 volts peak
Input Impedance	5000 ohms nominal
Residual FM	Less than 0.001% deviation above 1 watt Less than 0.01% deviation at 50 mw
Residual AM	Less than 1% above 1 watt Less than 10% at 50 mw
INPUT POWER	105-125 volts AC, 60 cycles, 5 amperes maximum
AMBIENT TEMPERATURE	
Operating	-10 to +120° F
Storage	-30 to +150° F
DIMENSIONS	
Height	10 inches
Width	6-3/4 inches
Length	18-1/2 inches
WEIGHT	35 pounds

D. 230V AC OPERATION

When 230V AC operation is specified on customer order, a 230V/115V step-down power transformer, Assembly C02381900, is factory mounted on the rear of the Signal Generator.



For 230V AC Operation:

Plug the line cord from the Model 470A-500 or 470A-1000 into the 115V output of the 230V/115V transformer assembly, C02381900, and plug the line cord from the transformer assembly into the 230V AC line.

For 115V AC Operation:

Plug the line cord from the Model 470A-500 or 470A-1000 directly into the 115V AC line.

SECTION II
OPERATION

A. FRONT PANEL CONTROLS AND FUNCTIONS (Refer to figure 2-1)

1. FUNCTION Switch

a. RESET/OFF position.

Resets grid overcurrent relay.

Turns off AC power to instrument.

b. STDBY/START position.

AC power applied to tube filament and low voltage power supplies.

Filament time delay relay starts cycle. Blower starts.

+15 volts starting voltage applied to SCR1 trigger control circuit.

Red AC panel light turned on.

When time delay relay completes its cycle amber READY light comes on.

CAUTION

If instrument has been turned off for less than two minutes, FUNCTION switch must be placed in STDBY/START position for at least one minute before turning to CW or modulated position to protect oscillator cathode. Time delay relay, K2, must cool off for about two minutes before it is ready to start another delay cycle.

c. CW position.

High voltage power supply turned on.

High voltage applied to RF oscillator tube.

d. 1 KC Square Wave position.

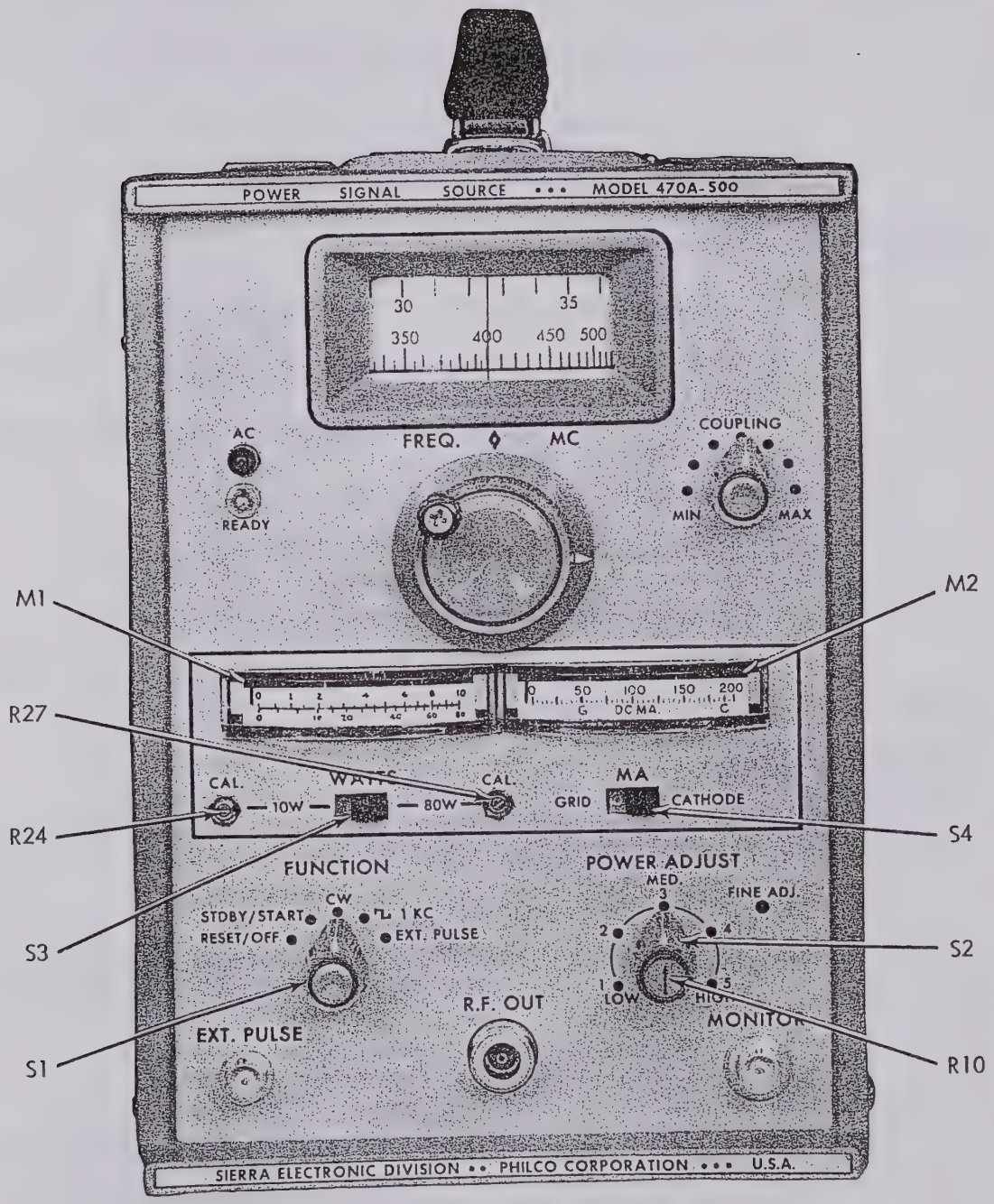


Figure 2-1. Front Panel Controls

High voltage applied to RF oscillator tube.

Power stabilizing resistor connected across high voltage supply output.

Modulator switched into RF oscillator cathode circuit.

Low voltage DC applied to 1 kc square wave generator.

1 kc square wave generator connected to modulator input.

e. EXT. PULSE position.

Functions are the same as for 1 kc square wave position except:

Square wave generator disconnected from modulator.

Modulator input connected to EXT. PULSE connector.

2. POWER ADJUST

Sets power output level.

Outer knob selects any one of five power switch positions.

Inner knob continuously adjusts power over a range slightly greater than the range between each switch position.

3. FREQUENCY-MC

Tuning knob adjusts oscillator to frequency indicated on the drum dial.

4. COUPLING

Sets coupling to plate cavity for optimum power output conditions.

5. WATTS

Slide switch selects either 10 watt or 80 watt meter range.

6. MA

Slide switch connects meter to read either Grid or Cathode current.

B. OPERATION

The Signal Generator may be set up in any convenient position except that the rear of the cabinet must not be blocked or obstructed so that free air flow to the blower is cut off or impaired.

NOTE

The following are the maximum limits for operation of the instrument when using the Machlett ML-7211:

Plate voltage	1000 volts max. (POWER ADJUST controls maximum clockwise positions.)
Cathode current	190 ma max.
Grid current	45 ma max.
Plate dissipation	100 watts max.

To calculate plate dissipation assume plate voltage of 1000 volts. Other values are as read from Cathode, Grid and Power Output meter. Plate dissipation is equal to: Plate voltage times the difference between Cathode and Grid current, minus the power output.

$$P_{diss} = 1000(I_k - I_g) - P_{out}$$

Since power output obtainable from the oscillator tube varies with frequency, the maximum plate dissipation rating must be kept in mind, especially near the ends of the band. The output may be adjusted to any obtainable power out so long as no one of the maximum ratings is exceeded.

1. With instrument plugged into a 117 volt, 60 cycle, AC supply, place FUNCTION switch in STDBY/START position.

2. Connect load or instrument to be tested to RF OUT.

3. If desired, connect frequency monitoring equipment to MONITOR. Monitor output is about 30 db below the RF output.

4. Set FREQUENCY dial to desired frequency.

5. If external modulation is to be used, connect modulating source to EXT. PULSE connector. Use positive going pulses of more than 2 volts peak-to-peak.

6. Set POWER ADJUST switch to LOW. (Low position provides power output up to 1 watt, MED position up to 10 watts.)

7. Set FUNCTION switch for output condition desired.

8. Set power output to desired level as read on the WATTS meter using the POWER ADJUST control.

9. Set COUPLING control for optimum output. Do not reduce coupling to the extent that grid current becomes excessive.

10. When highest power range is used, cathode current must not exceed 190 ma. Grid current must not exceed 45 ma. A reduction of loading, high VSWR or insufficient output coupling will cause grid overcurrent relay to trip.

11. If grid overcurrent relay trips (wattmeter reading suddenly falls to zero and READY light goes out)(Grid/Cathode meter reads relay holding current, about 40 ma.):

Turn FUNCTION switch to RESET/OFF and then back to STDBY/START.

Reduce power setting with POWER ADJUST control.

Increase COUPLING setting if necessary.

Check load or instrument being tested for proper impedance match.

Proceed as above in 7, 8, and 9.

12. If minimum rated output power is not achieved by setting the POWER ADJUST controls to minimum, increase the COUPLING. This loads down the oscillator and reduces the output.

C. RESTRICTED FREQUENCY RANGE POWER METER CALIBRATION

To obtain maximum power output meter accuracy over a narrow range of frequencies proceed as follows:

1. Connect RF OUT to a precision Calorimeter or RF Wattmeter. Use a short, low loss cable, such as RG8/U.

2. Set FREQUENCY dial to desired frequency.

3. Set power meter slide switch to 10W position.

4. Adjust power output until Calorimeter or RF Wattmeter reads exactly 10 watts.

5. Adjust left CAL control until power meter reads exactly 10 watts.

6. Set power meter slide switch to 80W position.

7. Adjust power output until Calorimeter or RF Wattmeter reads exactly 65 watts (or the maximum power level that is to be used).

8. Adjust right CAL control until power meter reads exactly the same as the Calorimeter or RF Wattmeter.

Power meter accuracy will now be ±0.2 db over a relatively narrow band adjacent to the frequency at which the Power Signal Source was calibrated.

SECTION III
CIRCUIT DESCRIPTION

A. RF POWER SOURCE

The RF power source is a self-excited, resonant cavity tuned oscillator. The tube used is a planar triode, Machlett type ML-7211. The similar tube, type 2C39A, may be used in the instrument with a consequent reduction in efficiency and power output if the proper modifications are made. See Section IV.

1. Oscillator

The oscillator tube, V1, is connected in a grounded grid circuit. Feedback to maintain oscillation is obtained by a factory adjusted probe joining the plate and cathode cavities. Tuning is accomplished by concentrically mounted pistons driven by the front panel controlled tuning mechanism. Cavity length, as adjusted by piston travel, determines the frequency of oscillation. Operating bias is set with the bias adjust control, R20. Refer to Schematic Diagram, Figure 4-6.

2. Output Coupling

A variable capacity probe in the plate cavity, adjusted by a front panel control, couples power to the external load through the RF OUT connector, J2. An auxiliary probe, also coupled to the plate cavity, furnishes an output for monitoring purposes through the MONITOR connector, J3. Monitor output level is approximately 30 db below the main signal output.

3. Power Output Metering

The power output is continuously metered by means of the directional coupler, DC1, and meter, M1. The meter range slide switch, S3, just below the meter, selects the proper multiplier resistors for the two ranges, 0-10 watts and 0-80 watts. R24 and R27 are the front panel calibration controls for the two power meter ranges.

4. Grid and Cathode Current Metering

Meter, M2, reads either the grid or the cathode current of the power oscillator tube, V1. The meter function selector is the slide switch, S4, located just below the Grid/Cathode meter. The meter multiplier resistor not being used is shunted out by meter switch, S4. Current flow through the meters may be traced in Figure 3-1.

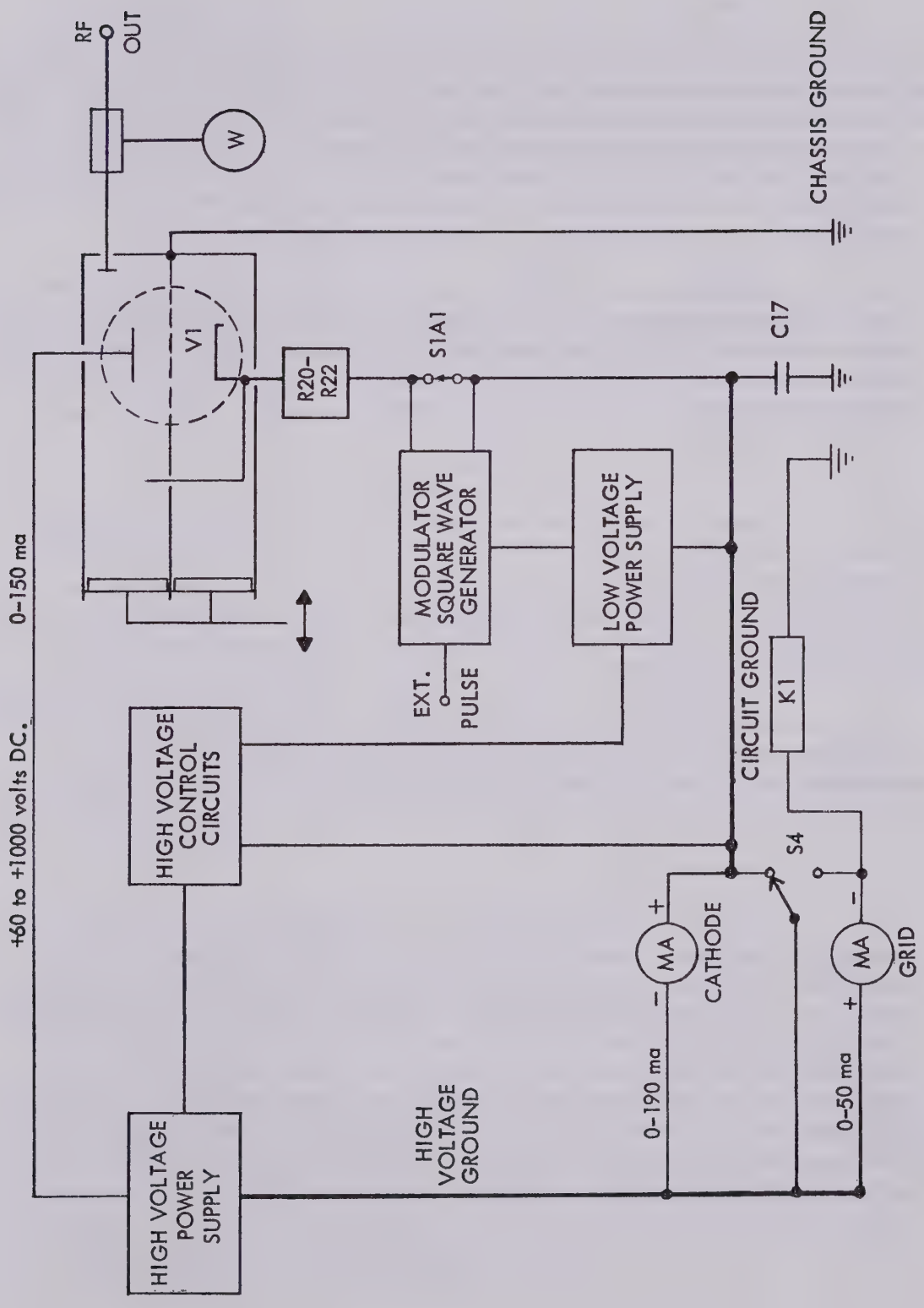


Figure 3-1. High Power Signal Generator Simplified Diagram

5. Excessive Grid Current Protection

Relay, K1, protects the oscillator tube against excessive grid current in the event the instrument is operated with no load, or high VSWR load, connected to the output, or if insufficient coupling is used to couple the load to the plate cavity. When K1 operates, one set of contacts shunts the SCR1 control circuit to the common bus, effectively turning off the high voltage power supply and at the same time turns off the READY light. The other set of contacts connects the output of the negative low voltage supply across the K1 coil, holding it in the power off position.

To restore the instrument to operation, the FUNCTION switch must momentarily be turned to the RESET/OFF position, operating the AC power switch, S1D, and returned to the STDBY/START position. This removes power from the low voltage supply long enough for the relay to reset. The load then may be adjusted and normal operation continued.

6. Excessive Plate Current Protection

Protection against excessive plate current is provided by fuse, F2, in the cathode circuit of V1.

B. MODULATION

The signal output may be modulated either by an external positive pulse or by the internally generated 1 kc square wave, as selected by FUNCTION switch, S1. The modulation duty cycle is limited to 50% at full power due to the extra load placed on the power supply by the stabilizing resistors.

1. Function Switch, Modulation Position

When the FUNCTION switch, S1, is placed in either modulation position, switch S1A1 removes the shunt from across Q6, placing the modulator in the cathode circuit of V1. S1A2 connects R4 and R5 across the high voltage supply as a stabilizing load in case the modulating signal is not applied during any interval of time the FUNCTION switch is in the EXT. PULSE position. Shorting type switches are used at S1A1 and S1A2 to prevent switching transients from affecting the SCR1 control and regulating circuits. S1B1 turns on the high voltage power supply for all operating modes. S1B2 connects the low voltage positive power supply to the modulator and 1 kc square wave generator in the modulation positions only. S1C selects either the internal square wave generator or an external modulating signal connected to J1.

2. Modulator

The modulator consists of transistor Q6 connected as a switch, controlled by Q5. The cathode current of V1 flowing through Q6 is either turned on or off so that signal modulation is 100%. A minimum peak signal amplitude of about +2 volts, applied to the base of Q5 through EXT. PULSE connector, J1, is required to turn on the oscillator output.

3. One Kc Square Wave Generator

Unijunction transistor Q2 is connected as a relaxation oscillator to produce the 1 kc internal modulating signal. The signal frequency is determined by the time constant of R29, R30 and C11. R30 is made adjustable for calibration purposes. The 1 kc output of Q2 triggers the bi-stable multivibrator Q3, Q4. The multivibrator output is a symmetrical square wave of the amplitude required to drive the modulator.

C. POWER SUPPLIES

Two power supply systems are used in the instrument: the high voltage power supply, including control circuits, which supplies the plate power to the signal source oscillator, V1, and the low voltage supply which provides the positive and negative voltages required by the modulator and the 1 kc square wave generator. The low voltage supply also furnishes positive pulsating DC to the SCR1 control circuit.

The common ground system is somewhat unconventional. There are three points in the instrument which are at or close to ground potential, but which must be separated for proper circuit operation. They are shown in Figure 3-1 as: chassis ground, circuit ground and high voltage ground.

1. Low Voltage Power Supply

a. Positive 117 Volt Supply. The positive, pulsating DC necessary for operation of the SCR1 control circuit is furnished by a bridge rectifier, CR20-CR23, connected across the 117 volt secondary of low voltage transformer, T1.

b. Positive 15 Volt Supply. For this supply a connection is taken from the positive side of the 117 volt rectifier through diode CR24. CR24 is used to isolate the filter components, R28-C9, of the +15 volt supply from the output of the bridge rectifier in order to maintain the 117 volt output as pulsating DC. Zener diode, CR25, with current limiting resistor, R28, regulates the output to +15 volts. One +15 volt connection goes to the SCR1 control circuit, to be explained later. The other output is connected to the modulator and square wave generator by S1B2 when the FUNCTION switch is in either of the modulation positions.

c. Negative 15 Volt Supply. A half-wave rectifier diode, CR26, is connected to the 12 volt secondary of the low voltage transformer, one side of which is connected to the circuit ground. The negative output supplies the voltage required to bias off the modulator transistors. This supply also provides the holding current for the no-load relay, K1.

2. High Voltage Power Supply and Control Circuits

The high voltage supply is regulated and controlled by a closed loop system containing the high voltage transformer, the bridge rectifier and filter, the SCR and SCR control circuits, and the power adjust circuits for coarse and fine control. Refer to Block Diagram Figure 1-2 and Schematic Diagram Figure 4-6.

a. High Voltage Power Transformer and Rectifier. AC power is applied to the primary of the high voltage transformer, T2, through switch selected voltage taps and in series with SCR1 control rectifier and its associated steering diodes, CR1-CR4. The taps in the primary of T2, selected by S2B, are the coarse steps of the POWER ADJUST control.

The two lowest voltage taps are formed by a tapped resistor in series with the primary of the transformer. This method of extending the control range is adopted to reduce transformer size and weight and also to reduce the voltage appearing at the low voltage tap, due to autotransformer action, when the high voltage tap is in use. To prevent arcing at the contacts, a shorting type switch is used at S2B to maintain the circuit through the transformer primary until after the SCR1 control circuit has been turned off by switch S2C. S2C is non-shorting so it opens slightly before S2B.

The secondary of T2 is connected to a bridge type rectifier, CR5-CR16, the output of which is filtered by L1-C4, C5. C6 tunes the filter choke to provide additional 120 cycle suppression. The output voltage of the rectifier is determined by the transformer primary tap setting and the width of the current pulse allowed to flow in the primary by the adjustable control action of SCR1. Thus the power supply voltage, and consequently the power output of the oscillator, V1, is variable over a wide range.

b. SCR1 and Control Circuits. Current will flow through SCR1 only after a triggering pulse has been applied to the gating electrode. Current flow, once started, will continue until the anode voltage approaches zero, or the current falls below a minimum level. The steering diodes route each half-cycle of AC to the anode of the SCR1, making it a full wave rectifier if it is triggered each half-cycle.

The SCR1 control circuit provides a triggering pulse every half-cycle of the power line frequency. Pulse timing is adjusted by the setting of the FINE knob of the POWER ADJUST control. The triggering pulse is applied to the gating electrode of SCR1 through the secondary of pulse transformer, T3. Generation and timing is accomplished with unijunction transistor, Q1, and associated circuits.

Stability of triggering operation requires that the voltage on B2 of Q1 be maintained at a relatively constant level. This level is adjustable over a narrow range by means of R10 to provide FINE timing control. The level is maintained in the neighborhood of +15 volts. To assure triggering of SCR1 and operation of the power supply when the FUNCTION switch is first placed in any of the operating positions, S1B2 applies +15 volts to C8 when in the STDBY/START position.

The resistors connected to switch decks S2A and S2D form a voltage divider circuit across the high voltage supply output to provide a feedback voltage for the control system. They are so chosen as to maintain the proper voltage level across R10 when the POWER ADJUST switch is changed. However, unless prevented, a high voltage surge would be applied across R10 when switching to a lower power level due to the voltage of the charge remaining on filter capacitor, C5. This surge is eliminated by using a shorting type switch at S2A. As the switch passes through the intermediate contacts, the circuit is momentarily connected to the high voltage ground through R53 and the charge on C5 is drained off. At the same time a circuit is completed to the circuit ground through S2E and S2A which applies +15 volts from the low voltage power supply to capacitor, C8, to maintain the proper voltage level between B2 and circuit ground during switching.

With a given voltage across Q1 between B2 and the circuit ground, the voltage at the emitter of Q1 must rise to roughly 50% of B2 voltage before conduction from emitter to B1 takes place. If the voltage on B2 is changed, the emitter voltage that will cause conduction to B1 is also changed. R10 adjusts the voltage on B2 to control the emitter-B1 conduction point.

When emitter-B1 conduction takes place capacitor, C7, discharges through Q1 and the primary of T3, generating a pulse across both primary and secondary. The pulse across the secondary of T3 is the triggering pulse for SCR1 while the primary pulse triggers SCR2 as will be explained later.

Zener diode, CR19, makes it possible to set the voltage divider 30 volts above the +15 volts required by Q1 so that a change in the high level output voltage causes a proportionately larger change in the control voltage across R10. The control voltage is thus made large enough to provide adequate regulation of the output of the power supply.

The pulsating DC output of the 117 volt rectifier is applied to the trigger control circuit through switches S1B1 and S2C and current limiting resistor R6. A pulsating voltage is necessary at this point in order that SCR2 may become non-conducting at the end of each half-cycle. Zener diode, CR17, clips the amplitude of the pulsating DC to about 11 volts and this voltage is applied to C7 through R55 and R7.

The point of time on each AC half-cycle at which C7 reaches a voltage high enough to cause it to discharge through Q1 to generate the SCR1 triggering pulse is determined by the time constant of R7-C7 and by the voltage at B2 of Q1 as set by R10. For stability of control, triggering takes place at a point on the AC half-cycle after it has passed its maximum voltage point and before it reaches zero.

When the triggering pulse for SCR1 is generated by the discharge of C7 through Q1 and T3, as described above, the pulse which appears across the primary of T3 is applied to the gate electrode of SCR2 through CR18. SCR2 is triggered into conduction and forms a low resistance path to the circuit ground. This clamps Q1 emitter to circuit ground potential for the remainder of the AC half-cycle. At the end of the half-cycle SCR2 becomes non-conducting, as noted above, and the circuit is ready to start charging C7 on the next half-cycle. This clamping action is necessary to stabilize the SCR1 triggering point.

3. Other Power Supply Circuits

a. Oscillator Tube Heater Voltage Supply. The heater voltage of V1 is adjusted by R50 and regulated by ballast tube R60. To obtain the full expected service life from the oscillator tube the voltage must be adjusted to the rated 5.9 volts whenever a new tube is installed. Heater voltage is maintained within the required ±5% by the ballast tube. (A new ballast tube should be aged for at least a half-hour and filament voltage reset.) It also prevents a heavy inrush of filament current when the instrument is turned on, thus prolonging tube life. The range of adjustment of R50 is sufficient to accommodate a 2C39A type tube. The current drawn by the ML-7211 filament is 1.3 amperes while the 2C39A draws 1.0 ampere.

b. Time Delay. Thermal time delay relay, K2, prevents the application of high voltage to the oscillator tube, V1, until the heater has come up to operating temperature. Delay time is about one minute. Amber READY light, DS2, comes on when K2 closes indicating the ready to operate condition. Refer to CAUTION note in Section II , paragraph A, regarding K2 operation.

SECTION IV
MAINTENANCE

A. ACCESS TO COMPONENTS

All components are readily accessible when the side panels are removed. The panels may be removed by unscrewing the two 6-32 screws near the top of each panel. The snap-in hole plug in the rear may be lifted out with a screw driver or other flat instrument.

To get to the components on the rear of the circuit boards remove the screw at each end and swing the board toward the front of the instrument.

WARNING

Lethal voltages are present within the equipment when in operation. Be sure AC power is disconnected and capacitors are discharged before reaching inside the instrument when performing service or maintenance.

B. PREVENTIVE

1. Blower

The blower motor bearings are lubricated for the life of the motor. Any accumulation of dust in the impeller should be brushed out.

2. Filter

The filter over the blower intake should be cleaned whenever it shows an accumulation of dust. To clean, wash filter gently in hot soapy water to remove dirt. Rinse clean, shake off excess water and allow to dry. Before replacing filter, re-coat it with RP Super Filter Coat Adhesive (available from Research Products Corporation, Madison 1, Wis.) or equivalent. Spray both sides evenly with several thin coats.

3. Tuning Mechanism

The threaded rod connected to the frequency tuning knob should be cleaned and relubricated when it begins to show an accumulation of dust. The moving sleeve to the threaded rod contact has a self-cleaning action so it will not need frequent attention. To clean, hold a small square guaze pad on the threads and turn the frequency

tuning knob. Work back and forth until all old lubricant and dust is removed. When thread is clean, saturate a small square of clean gauze with Dow Corning 44 silicone lubricant and hold on thread while turning the frequency tuning knob. A light film of lubricant over the full length of the thread is all that is necessary. Do not use other lubricants as they tend to dry out and also cause oxidation.

C. TROUBLESHOOTING

Be sure you know where high voltages are exposed in the wiring and keep clear of these points when checking operation with the equipment energized. Warning labels indicate general danger areas only. In addition to the high voltage circuit board, high voltages are present on the anode fins of the oscillator tube, the connections to the two Daleohm resistors mounted on the rear panel just above the oscillator tube, the connections to the high voltage choke, L1, and on the front deck of both the FUNCTION switch and the POWER ADJUST switch.

A good understanding of the circuit operation as outlined in Section III will aid in tracing a case of trouble to one section of the instrument and localizing it there. Pertinent voltages are shown on the schematic diagram, Figure 4-6. If the cause of a trouble is not immediately apparent the voltages should be checked first. See Figure 4-1 thru 4-4 for component location.

Do not change any of the internal adjustments in an attempt to correct trouble. These adjustments should be made only in accordance with adjustment procedure given in the ADJUSTMENT paragraph below.

LIST OF POSSIBLE TROUBLES

Trouble Indication	Possible Cause
AC panel light does not come on when FUNCTION switch is placed in STDBY/START position.	1. Cord not plugged into AC source. 2. Fuse, F1, blown.
Fuse, F1, blown.	1. SCR1 shorted. 2. Loose or broken connection to R12.

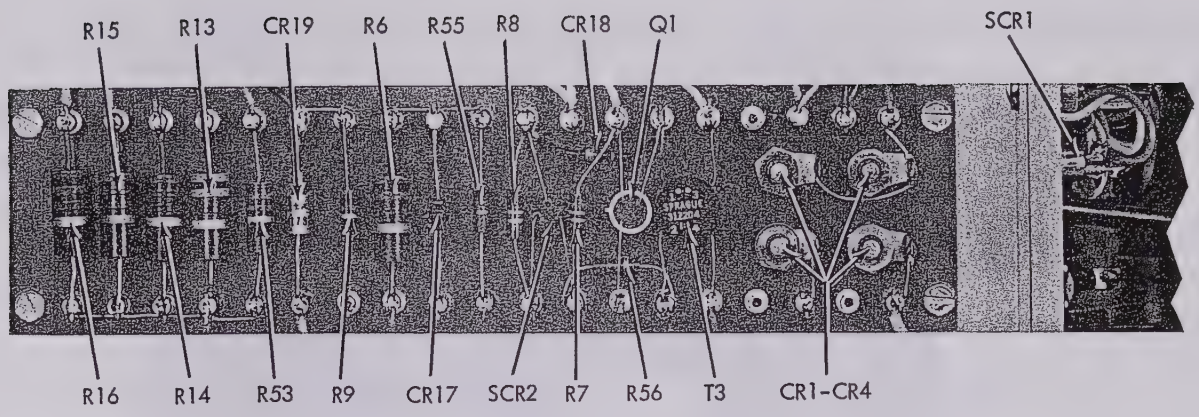


Figure 4-1. SCR, HV Control Circuits, Top Circuit Board

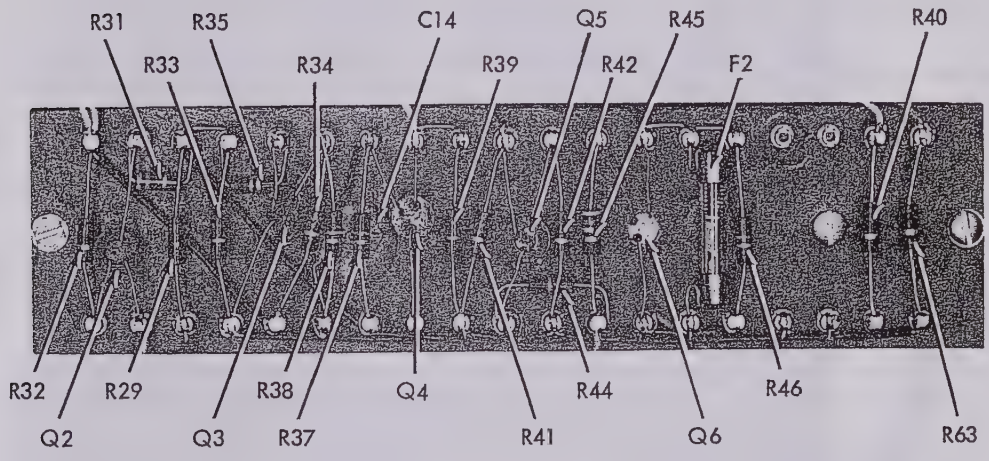


Figure 4-2. 1 kc Oscillator, Modulator Circuits, Middle Circuit Board

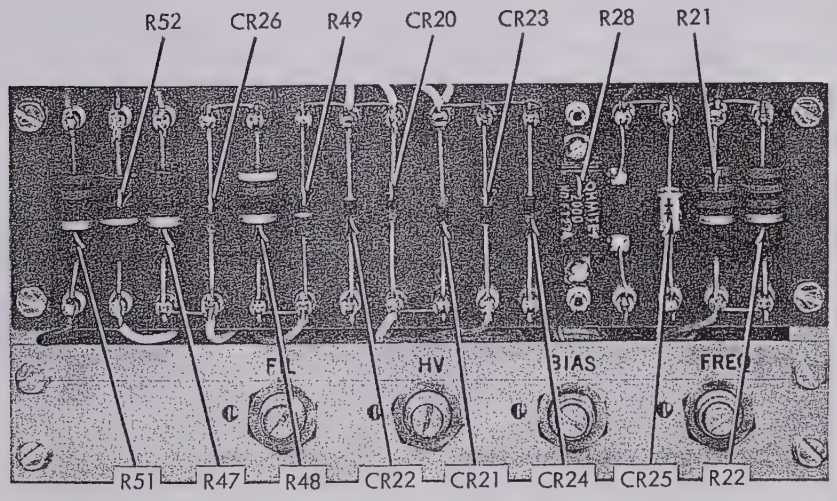
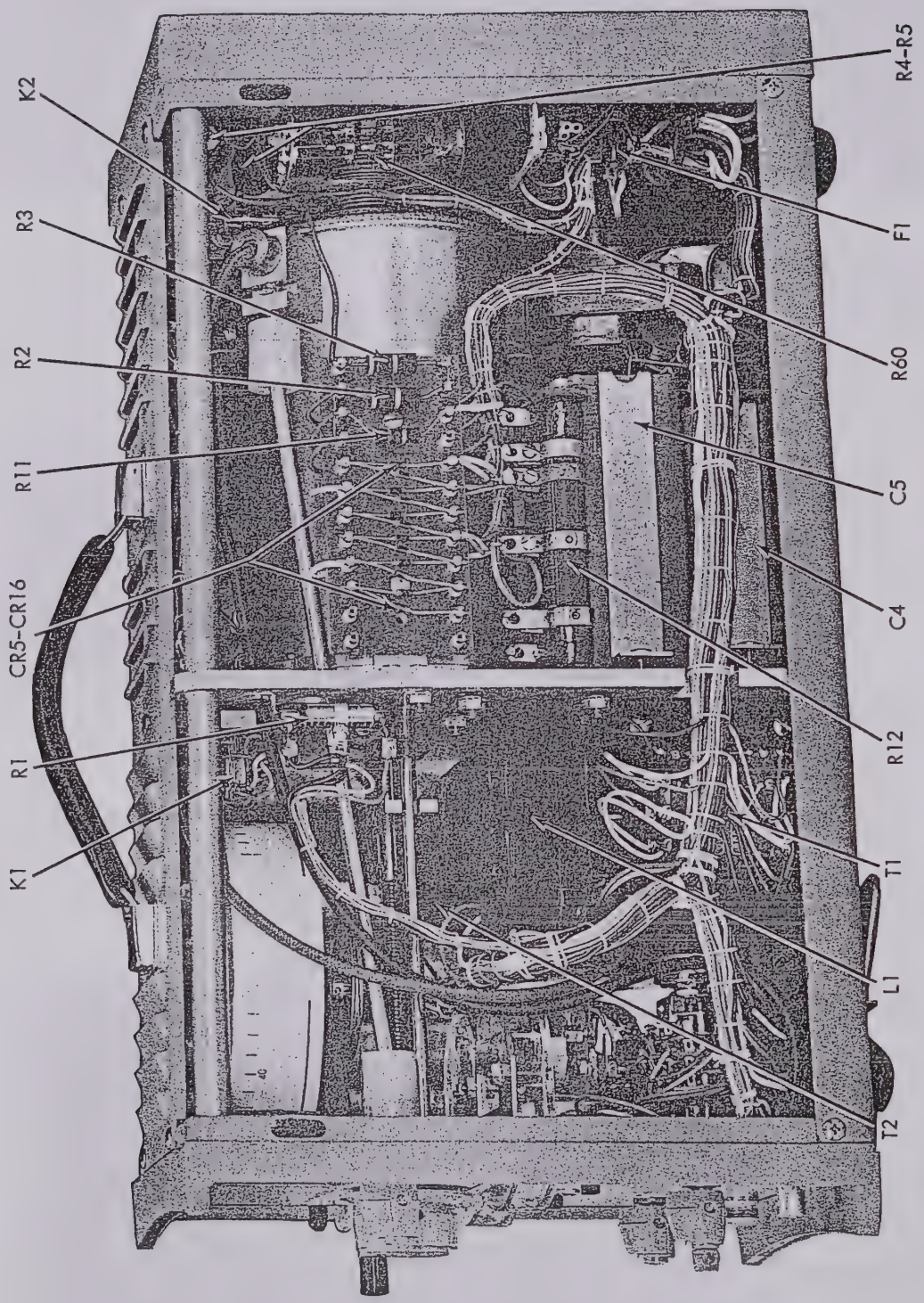


Figure 4-3. 117 volt and ±15 volt DC Circuits, Bottom Circuit Board


K2
R3
R2
R11
CR5-CR16
R1
K1
R4-R5
F1
R60
C5
C4
R12
T1
L1
T2

Trouble Indication	Possible Cause
	3. CR1-CR2 or CR3-CR4 shorted. 4. SCR2 or CR18 open.
No filament voltage on V1.	1. Ballast tube, R60, open.
READY light does not light although instrument has been on for several minutes.	1. Relay, K2, not closing. 2. Normally closed contacts of relay K1 in indicator light circuit dirty or not making properly.
No -15 volts to modulator.	1. C10 shorted. 2. CR26 open.
No +15 volts to arm of S1B2.	1. C9 shorted. 2. CR24 open. 3. CR20-23 diodes faulty.
Excessive voltage at arm of S1B2.	1. CR25 open.
READY light comes on but no high voltage to anode of oscillator tube, V1.	1. Diodes CR20-23 faulty (no 117 volts DC output). 2. CR17 shorted. 3. SCR2 faulty (conducting continuously).

Trouble Indication	Possible Cause
	4. No +15 volts applied to C8 when FUNCTION switch in STDBY/START position. 5. Q1 faulty. 6. CR18 shorted. 7. T3 open circuited. 8. SCR1 faulty (will not trigger on). 9. Diodes CR1-4 open. 10. Transformer, T2, open circuited. 11. Diodes CR5-16 faulty.
Relay, K1, chatters and READY light flashes at a rate proportional to POWER ADJUST setting.	1. V1 grid-plate arc. 2. Cavity anode by-pass capacitor short circuited. 3. C4, C5, L1, R4 or R5 short circuited to ground.
Fuse, F2, blows.	1. SCR1 short circuited, and a higher than specified rating fuse at F1.
High voltage excessively high (about 1600 volts).	1. SCR1 shorted.

Trouble Indication	Possible Cause
No modulation in 1 kc square wave FUNCTION switch position.	1. Q5 or Q6 faulty (try EXT. PULSE position with external signal). 2. No +15 volts to modulator and 1 kc square wave generator. 3. Q3 or Q4 faulty. 4. Q2 faulty. 5. C11 shorted.

D. ADJUSTMENT

1. Equipment Required, as listed or equivalent

a. Multimeter, Simpson 260.

b. Metered Variable AC Source, General Radio GRW5MT3A.

c. Termination Wattmeter (470A- 500) Sierra Model 401A-120M
(470A-1000) Sierra Model 401A-120H

d. Directional Coupler, Sierra Model 642A.

e. Termination Load, Sierra Model 160-1FN.

f. Square-Wave Generator, HP 211A.

g. Frequency Counter, HP 5254A.

h. Frequency Counter, HP 5245L.

i. Crystal Detector, Sierra Model 148

j. Resistors, 100 ohm, 1/2W, 10%, and 600 ohm, 1/2W, 10%.

k. Oscilloscope, Tektronix 543.

2. Preliminary Adjustments

Check to see that the following adjustments are correctly set:

a. R20 so that total bias resistance (R21-22, R20) is 135 ohms.

b. Adjustable resistor R1 tap set at mid-range.

c. Adjustable resistor R12 taps set to the following values measured from the high voltage end of resistor:

Tap 1	2.5K	(Factory adjustments may vary slightly from these values. Do not readjust unless settings have quite evidently been moved).
Tap 2	6K	
Tap 3	20K	
Tap 4	34K	

d. Cathode and plate line pushrods.

Pushrod adjustment should never be changed from the factory setting. If rod adjustment has apparently been changed, and specified performance is not obtainable with the following adjustment procedure, the instrument should be returned to the factory for repair.

3. Adjustment Procedure

a. Connect test equipment as shown in Figure 4-5.

b. Preliminary settings.

(1) Set AC source voltage to 117 volts.

(2) Place FUNCTION switch in STDBY/START position.

(3) Check time delay relay timing, approximately 60 seconds.

(4) Adjust filament voltage to 5.9 volts AC ±0.1V. Be sure ballast tube R60 has had time to stabilize: 1/2 hour for new tube, 2 minutes for tube that has been in service. (See Figures 4-1 to 4-4 for component location.)

(5) Check voltage of +100VDC, ±15VDC, -15VDC supplies.

c. POWER ADJUST switch ranges.

(1) Set COUPLING control to maximum (stops oscillation).

(2) Set POWER ADJUST switch to position 5 and FINE control to maximum clockwise.

(3) Adjust HV control, R17, for power supply output of 1000 volts.

CAUTION

Turn off power when adjusting R12.
One end is at power supply high
voltage potential.

(4) Set POWER ADJUST switch to each setting. Check with FINE control to make sure that ranges overlap. If they do not, adjust taps on R12 until they do.

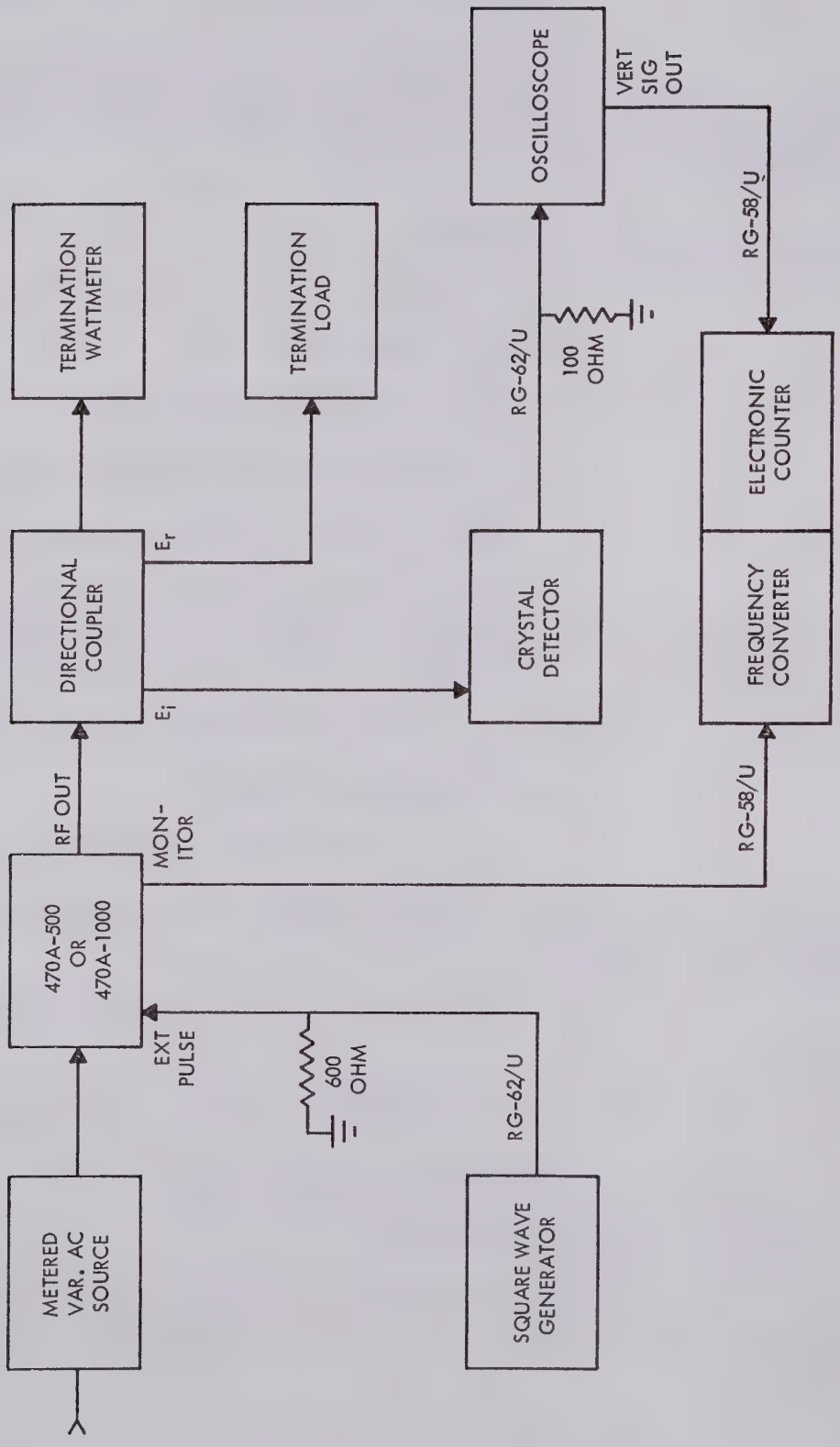


Figure 4-5. Test Equipment Connections

(5) Check sawtooth output of Q1 over all power adjust switch ranges. If alternate cycle triggering is observed refer to Note 3 on schematic diagram.

d. Oscillator Operation Model 470A-500

NOTE

Monitor the detected wave form on an oscilloscope at all times during testing to insure that no spurious modulation occurs as a result of an improper adjustment.

(1) Set frequency at 500 mc and adjust COUPLING for maximum output.

(2) Set POWER ADJUST controls for 60 watts output within the following voltage and current limits:

Plate Voltage	1000 volts DC max. (POWER ADJUST controls maximum clockwise position.)
Grid current	45 ma max.
Cathode Current	190 ma max.

At no setting should the plate dissipation be allowed to exceed 100 watts, the rated dissipation of the oscillator tube. To calculate plate dissipation assume plate voltage of 1000 volts. Other values as read from Cathode, Grid and Power Output meters. Plate dissipation is equal to: Plate voltage times the difference between Cathode and Grid current, minus the power output.

$$P_{diss} = 1000 (I_k - I_g) - P_{out}$$

(See para. 4 for 2C39A maximum limits.)

(3) Check at 200 mc.

e. Oscillator Operation Model 470A-1000

Follow procedure as given under d. above except that power output is 55 watts and frequencies are 1000 mc and 470 mc.

f. Frequency Adjustment Model 470A-500

(1) Adjust output for 50 watts at optimum coupling.

(2) Adjust to 500 mc as read on Electronic Counter. Check instrument dial indication. Should read within 1%. Check dial frequency over operating range. If reading is seriously in error, loosen set screw on dial drum and adjust setting until it is within the proper limits.

g. Frequency Adjust Model 470A-1000

Procedure same as in f. above except that dial is initially set to 1000 mc.

h. Modulation Frequency Adjustment

(1) Set FUNCTION switch to 1 kc square-wave.

(2) Observe modulated output on oscilloscope and adjust Freq. control, R30, until frequency of square-wave is 1000 cycles. Amplitude should be 5V p-p.

i. RF Wattmeter Calibration

Model 470A-500, calibrate at 350 mc.

Model 470A-1000, calibrate at 750 mc.

(1) Adjust output to 10 watts as read on Termination Wattmeter. Place meter switch, S3, in the 10 watt position.

(2) Adjust the left CAL adjustment control, R24, until WATTS meter reads 10 watts.

(3) Set output to 60 watts as read on power monitor. Place meter switch, S3, to 80 watt position.

(4) Adjust the right CAL adjustment control, R27, until WATTS meter reads 60 watts.

4. Adjustment for 2C39A oscillator tube.

a. Turn FIL control, R50, full CCW.

b. Install 2C39A tube.

c. Turn instrument on and adjust filament voltage to 5.9 volts AC. After instrument has been on for several minutes (ballast tube stabilizes) recheck filament voltage and adjust as necessary.

d. The following maximum limits should be observed:

Plate voltage	1000 volts DC max.
Grid current	50 ma max.
Cathode current	125 ma max.

At no setting should the plate dissipation be allowed to exceed 100 watts. See paragraph D. 3. d. (2). Maximum power output obtainable from the 2C39A (within ratings) will vary with frequency, but will be considerably less than when using a ML7211.

REPLACEABLE PARTS LIST

PARTS REPLACEMENT

Standard components have been used in this instrument whenever possible. Both standard and special components may be ordered direct from the factory.

When ordering parts always include:

1. Sierra Stock Number.
2. Circuit Reference and Commercial Description.
3. Name, Model and Serial Number of the Instrument.

Parts for this instrument, or further service information may be obtained from:

SIERRA ELECTRONIC DIVISION
Philco Corporation
3885 Bohannon Drive
Menlo Park, California 94025

Telephone (415) 322-7222
TWX 910-373-1282

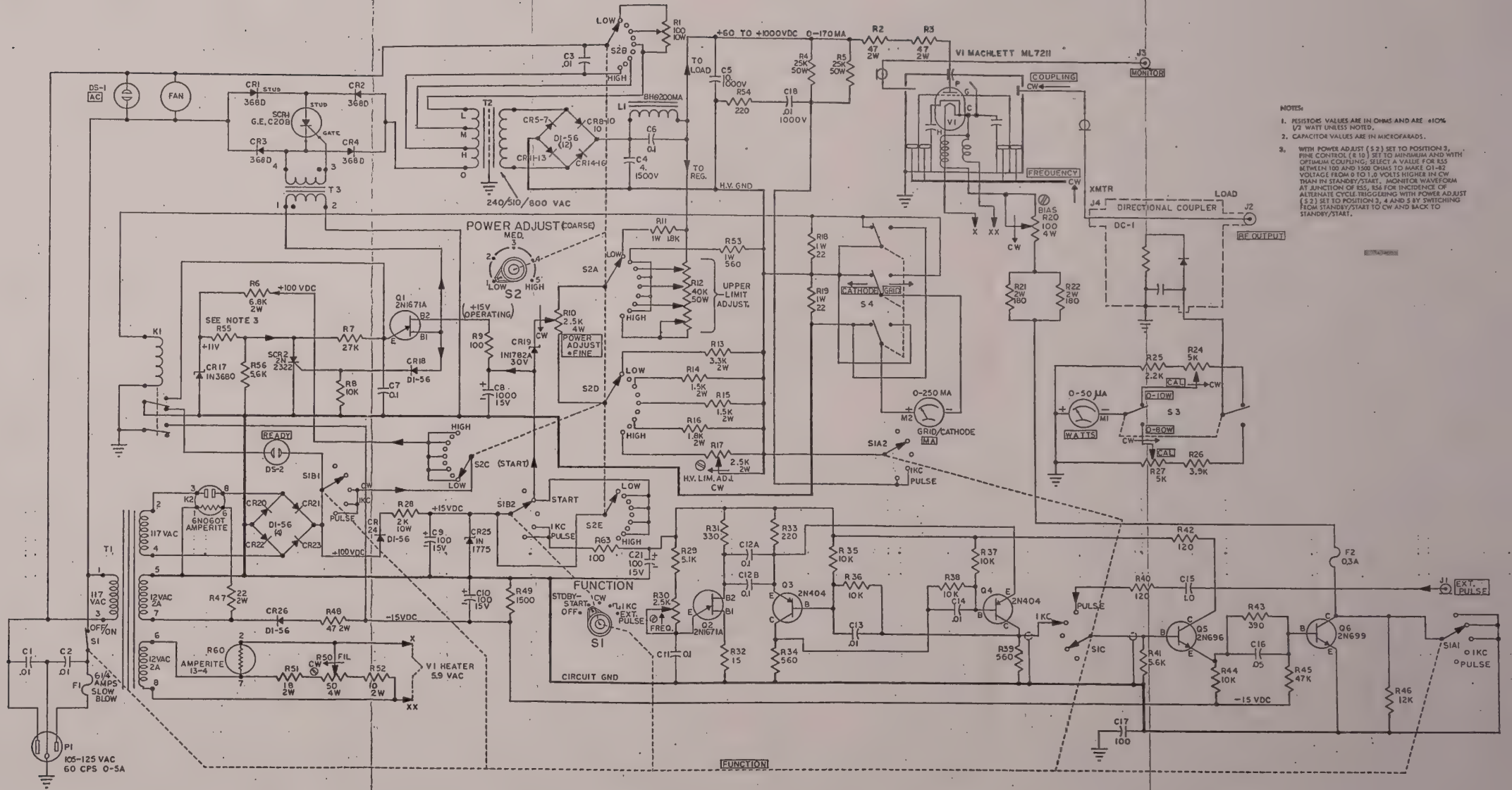

POWER ADJUST (COARSE)
FUNCTION
VI MACHLETT ML7211
+60 TO +1000VDC 0-170MA
240/510/800 VAC
117 VAC
12VAC 2A
12VAC 2A
105-125 VAC 60 CPS 0-5A
6¼ AMPS SLOW BLOW
VI HEATER 5.9 VAC
+100 VDC
+15VDC
-15VDC
-15 VDC
+15V OPERATING
H.V. GND
CIRCUIT GND
TO LOAD
TO REG.
UPPER LIMIT ADJUST.
H.V. LIM. ADJ.
POWER ADJUST • FINE
0-250 MA
GRID/CATHODE MA
0-50 MA
WATTS
DIRECTIONAL COUPLER
BIAS R20 100 4W
COUPLING
FREQUENCY
XMTR
LOAD
RF OUTPUT
MONITOR
EXT. PULSE
1KC PULSE
SEE NOTE 3
READY
START
CAL
0-10W
0-80W
NOTES:
1. RESISTORS VALUES ARE IN OHMS AND ARE ±10% 1/2 WATT UNLESS NOTED.
2. CAPACITOR VALUES ARE IN MICROFARADS.
3. WITH POWER ADJUST (S2) SET TO POSITION 3, FINE CONTROL (R10) SET TO MINIMUM AND WITH OPTIMUM COUPLING; SELECT A VALUE FOR R55 BETWEEN 100 AND 1500 OHMS TO MAKE Q1-B2 VOLTAGE FROM 0 TO 1.0 VOLTS HIGHER IN CW THAN IN STANDBY/START. MONITOR WAVEFORM AT JUNCTION OF R55, R56 FOR INCIDENCE OF ALTERNATE CYCLE TRIGGERING WITH POWER ADJUST (S2) SET TO POSITION 3, 4 AND 5 BY SWITCHING FROM STANDBY/START TO CW AND BACK TO STANDBY/START.

Figure 4-6. Model 470A-500 and 470A-1000 Schematic Diagram

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
C1	CAPACITOR, Discap, .01µf ±20% 600 VDC	901400103	Sprague	292C9B6	5
C2	SAME AS C1				
C3	SAME AS C1				
C4	CAPACITOR, Paper, 4µf 1500 VDC, Metal Cased Oil Filled with Bracket	901230405	Sangamo 7115-4B	CP70B1FH405K1	1
C5	CAPACITOR, Paper, 10µf 1000 VDC, Metal Cased Oil Filled with Bracket	901230106	Sangamo 7110-10B	CP70B1FG106K1	1
C6	CAPACITOR, Tubular Paper, 0.1µf ±20% 400 VDC	901020104			1
C7	CAPACITOR, Tubular Paper, 0.1µf 100V	901040104	Sprague	CP08A1EB104K	2
C8	CAPACITOR, Electrolytic, Tubular, 1000µf 15 VDC	902240108	Sangamo	MT-133	1
C9	CAPACITOR, Electrolytic, Tubular, 100µf 15 VDC	902230107	Sprague	TE 1162	3
C10	SAME AS C9				
C11	SAME AS C7				
C12A	CAPACITOR, Discap, 0.1µf 50VDC	901410104	Sprague	33C41	1
C12B	SAME AS C12A				
C13	SAME AS C1				
C14	SAME AS C1				
C15	CAPACITOR, Metalized Paper, 1µf ±5% 400 VDC	902420105	Texas	1017	1
C16	CAPACITOR, Discap. .05 µf, ±20% 500VDC	901400503	Sprague	5HK-S50	1
C17	CAPACITOR, Elect. NP, 100µf, 50VDC, PCB type	903300107	Nashville Elec.		1
C18	CAPACITOR, Discap, .01µf, 1000VDC	901410103	CRL	DD-103	1
C19-20	Not Used				
C21	Same as C9				
CR1	DIODE, 200V PIV, 5A	910500025	Westinghouse	368D	4
CR2	SAME AS CR1				
CR3	SAME AS CR1				
CR4	SAME AS CR1				
CR5	DIODE, 600 PIV, 0.75A	910800008	Diodes, Inc.	DI-56	19
CR6	SAME AS CR5				
CR7	SAME AS CR5				
CR8	SAME AS CR5				
CR9	SAME AS CR5				
CR10	SAME AS CR5				
CR11	SAME AS CR5				
CR12	SAME AS CR5				
CR13	SAME AS CR5				
CR14	SAME AS CR5				
CR15	SAME AS CR5				
CR16	SAME AS CR5				
CR17	DIODE, Zener, 11 VDC, 3/4 Watt	910500020	Motorola	1N3680	1
CR18	SAME AS CR5				
CR19	DIODE, Zener, 30 VDC ±5% 1 Watt	910500026	IRC	1N1782A	1
CR20	SAME AS CR5				
CR21	SAME AS CR5				
CR22	SAME AS CR5				
CR23	SAME AS CR5				
CR24	SAME AS CR5				
CR25	DIODE, Zener, 15 VDC, 1 Watt	910500043		1N1775	1
CR26	SAME AS CR5				
DS-1	PILOT LAMP, Neon, 115 VAC	913800018	Dialco	45H-56K-931	1
DS-2	LAMP CARTRIDGE, Neon, Clear	913800019	Dialco	45H-33K-935	1
DC-1	DIRECTIONAL COUPLER, 0-40 Watts, 150-1000 MC Type N Female Connectors	911600001	MC Jones Div., Bendix	573N4	1

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
F1	FUSE, 3AG, 6-1/4A, Slow Blow	913200035	Littelfuse	313.625	1
F2	FUSE, 0.3A With Wire Leads	913200025	Fusetron	MDV	1
J1	RECEPTACLE, BNC Female	914600035	Gremar	UG1094/U	1
J3	RECEPTACLE, BNC Bulkhead	914600072	Gremar	GRM1 5354	1
J4	CONNECTOR, "N" to RG58/U	914600054		UG536A/U	1
K1	RELAY, DPDT 2A, Coil 12 VDC	912600019	Potter and Brumfield	MG-11D	1
K2	RELAY, Time Delay, 6 Volts, Normally Open, 60 Second	912800007	Amperite	6NO60T	1
L1	CHOKE, Filter, 8 Henrys at 200 MA DC, Insulated for 1000 VDC Operation	909200034		SS-19494-2	1
M1	METER, Edgewise, 2 1/2 inch, 0-50 Microamps, 2000 Ohm	911800064	Beede	A01950200	1
M2	METER, Edgewise, 2 1/2 inch, 0-250 MA DC	911800065	Beede	A01951500	1
P1	POWER CORD, 3 Conductor No. 18, 6 Foot, with Molded Grounding Plug, Type SV	916400015	Belden	17236-S	1
Q1	UNIJUNCTION TRANSISTOR	910300010	General Electric	2N1671A	2
Q2	SAME AS Q1				
Q3	TRANSISTOR, Germanium PNP	910300007	RCA-Philco	2N404	2
Q4	SAME AS Q3				
Q5	TRANSISTOR, Silicon NPN	910300012	RCA	2N696	1
Q6	TRANSISTOR, Silicon NPN	910300013	G.I. - Fairchild	2N699	1
R1	RESISTOR, Wirewound, Adjustable, 100 ohm ±5%, 10 Watts with Mounting Clips	906500101	Ohmite	1012	1
R2	RESISTOR, Composition, 47 ohm ±10% 2 Watt	906000470	AB	Type HB	3
R3	SAME AS R2				
R4	RESISTOR, Wirewound, 25K ohm ±3% 50 Watt	906810253	Dale	RH50	2
R5	SAME AS R4				
R6	RESISTOR, Composition, 6.8K ohm ±10% 2 Watt	906000682	AB	Type HB	
R7	RESISTOR, Composition, 27K ohm ±5% 1/2 Watt	905000273	AB	Type EB	
R8	RESISTOR, Composition, 10K ohm ±10% 1/2 Watt	905200103	AB	Type EB	6
R9	RESISTOR, Composition, 100 ohm ±10% 1/2 Watt	905200101	AB	Type EB	2
R10	POTENTIOMETER, Wirewound, 2.5K ohm ±10% 5 Watt Short, Slotted Shaft, Part of S2 Assembly	907900154	CTS of Ashville	AW-0448-2.5K-6328	3
R11	RESISTOR, Composition, 1.8K ohm ±5% 2 Watt	905800182	AB	HB	2
R12	RESISTOR, Wirewound, Adjustable, 40K 50 Watt with 4 Adjustable Lugs No. 0358	906700403	Ohmite	0587	1
R13	RESISTOR, Composition, 3.3K ohm ±5% 2 Watt	905800332	AB	HB	
R14	RESISTOR, Composition, 1.5K ohm ±5% 2 Watt	905800152		HB	
R15	SAME AS R14				
R16	SAME AS R11				
R17	SAME AS R10				
R18	RESISTOR, Composition, 22 ohm ±10% 1 Watt	905600220	AB	GB	2
R19	SAME AS R18				
R20	POTENTIOMETER, Wirewound, 100 ohm ±10% 5 Watt Short, Slotted Shaft	907900155	CTS of Ashville	AW-0447-100Ω-6328	1
R21	RESISTOR, Composition, 180 ohm ±10% 2 Watt	906000181	AB	HB	2

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
R22	SAME AS R21				
R23	Not Used				
R24	POTENTIOMETER, Wirewound, 5K ohm 0.25 Watt, with Panel Mounting Bushing	907900156	Bourns	Trimit Model 373	2
R25	RESISTOR, Composition, 2.2K ohm ±10% 1/2 Watt	905200222	AB	EB	1
R26	RESISTOR, Composition, 3.9K ohm ±10% 1/2 Watt	905200392	AB	EB	1
R27	SAME AS R24				
R28	RESISTOR, Wirewound, 2K ohm ±5% 10 Watt	906410202	Ohmite	F127	1
R29	RESISTOR, Composition, 5.1K ohm ±5% 1/2 Watt	905000512	AB	EB	1
R30	SAME AS R10				
R31	RESISTOR, Composition, 330 ohm ±10% 1/2 Watt	905200331	AB	EB	1
R32	RESISTOR, Composition, 15 ohm ±5% 1/2 Watt	905000150	AB	EB	1
R33	RESISTOR, Composition, 220 ohm ±10% 1/2 Watt	905200221	AB	EB	2
R34	RESISTOR, Composition, 560 ohm ±10% 1/2Watt	905200561	AB	EB	3
R35	SAME AS R8				
R36	SAME AS R8				
R37	SAME AS R8				
R38	SAME AS R8				
R39	SAME AS R34				
R40	RESISTOR, Composition, 120 ohm ±10% 1/2 Watt	905200121	AB	EB	2
R41	RESISTOR, Composition, 5.6K ohm ±10% 1/2 Watt	905200562	AB	EB	2
R42	SAME AS R40				
R43	RESISTOR, Composition, 390 ohm ±5% 1/2 Watt	905000391	AB	EB	1
R44	SAME AS R8				
R45	RESISTOR, Composition, 47K ohm ±10% 1/2 Watt	905200473	AB	EB	1
R46	RESISTOR, Composition, 12K ohm ±10% 1/2 Watt	905200123	AB	EB	1
R47	RESISTOR, Composition, 22 ohm ±10% 2 Watt	906000220	AB	HB	1
R48	SAME AS R2				
R49	SAME AS R14				
R50	POTENTIOMETER, Wirewound, 50 ohm ±10% 5 Watt, with Short, Slotted Shaft	907900157	CTS of Ashville	AW-0446-50Ω-6328	1
R51	RESISTOR, Composition, 18 ohm ±10% 2 Watt	906000180	AB	HB	1
R52	RESISTOR, Composition, 10 ohm ±10% 2 Watt	906000100	AB	HB	1
R53	SAME AS R34				
R54	SAME AS R33				
R55	SELECTED				
R56	SAME AS R41				
R60	REGULATOR, Current, 1.3A 20 Watt, Ballast Tube	910900003	Amperite	13-4	1
R63	Same as R9				
S1	SWITCH, Rotary, with Rear Snap SW	911200089	Oak	Type F	1
S2	SWITCH, Rotary, with Rear Mounted Concentric Pot	911200090	Oak	Type F	1
S3	SWITCH, Slide, 3PDT, 0.5A	911000023	Continental Wirt	G-769	2
S4	SAME AS S3				
SCR-1	SILICON CONTROLLED RECTIFIER, 200V PIV, 7.4A	910400008	General Electric	C20B	1
SCR-2	SILICON CONTROLLED RECTIFIER, 25V PIV, 1.6A	910400007	General Electric	2N2322	1
T1	TRANSFORMER, Control, Primaries: 117/230 VAC 60 CPS. Secondaries: Two 12 VAC at 2 Amps	910000062	Stancor	P-6377	1
T2	TRANSFORMER, Plate, 200 VA, Primary Taps for 240, 510 and 800 VAC from 80 Volt SCR Control	910000063	Hill Magnetics		1
T3	PULSE TRANSFORMER, 1:1	909900007	Sprague	31Z204	1

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
V1	PLANAR TRIODE	910700106	Machlett	ML7211	1
XK1	SOCKET, 9 Pin, Black, Bottom Mounting	914000013	Eico	Model 270	1
XR60	SOCKET, 8 Pin Octal, Bottom Mounting	914000001			1
XF1	FUSE HOLDER	913400001			1
	BLOWER, 25 Watt, 3000 RPM,	917200008	Howard Industries	8506	1
	KNOB, Crank	916000057			1

Manufactured by

SIERRA ELECTRONIC DIV.

OF

PHILCO

A SUBSIDIARY OF Ford Motor Company

TELEPHONE (415) 322-7222 TWX 910-373-1282

Warranty

SIERRA ELECTRONIC DIVISION, PHILCO CORPORATION warrants instruments manufactured by it and bearing Sierra commercial model numbers, except Ion Gauge Tubes, to be free from defective material and factory workmanship and agrees to repair such instruments, which under normal use and service, disclose the defect to be the fault of our manufacturing. Our obligation under this warranty is limited to repairing any such instrument which in our sole opinion upon our examination proves to be so defective, when returned to our factory, transportation prepaid by the purchaser, within one year from the date of original purchase from us.

This warranty does not apply to any of our products which have been repaired, worked upon or altered by persons not authorized by us so as, in our sole judgment, to injure the stability or reliability of such instrument, or which have been subject to misuse, negligence or accident, or the serial number of which has been altered, effaced, or removed. Neither does this warranty apply to any of our products which have been connected, installed, used or adjusted otherwise than in accordance with the instructions furnished by us. Nor does SIERRA ELECTRONIC DIVISION, PHILCO CORPORATION assume any liability for consequential damages, and in any event our liability shall in no case exceed the original purchase price of the instrument. Accessories, including but not limited to all vacuum tubes, fuses and batteries, not of our manufacture used with this product are not covered by this warranty.

SIERRA ELECTRONIC DIVISION, PHILCO CORPORATION reserves the right to make changes in the design or construction of any of its instruments at any time without incurring any obligation to make any changes whatever on units previously purchased.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to represent nor assume for us any liability in connection with the sale of our products other than set forth herein.

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